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Influence of plant growth regulators on growth and flowering of China aster var. Arka Archana

Jemini Patel, Bhavesh Patel, Tejal Patel and TR Ahlawat

Abstract
A field experiment on "Influence of plant growth regulators on growth, flowering and yield of china aster" was conducted at Floriculture Research Farm, ASPEE College of Horticulture and Forestry, Navsari Agricultural University, Navsari during the *Rabi* season of 2020-2021. The experiment comprised of ten treatments *viz.*, GA_3 100 ppm, GA_3 150 ppm, GA_3 200 ppm, Salicylic acid 50 ppm, Salicylic acid 100 ppm, Salicylic acid 150 ppm, NAA 100 ppm, NAA 150 ppm and NAA 200 ppm along with no (water) spray. The experiment was laid out in randomized block design (RBD) with three replications in china aster var. 'Arka Archana'. Plant growth regulators were applied as foliar spray at 30 and 45 days after transplanting. The findings reveal that the various treatments had distinct impacts on the growth measures. Among different concentrations of plant growth regulators, GA_3 200 ppm was found numerically highest in plant height, number of primary branches per plant, stem diameter, plant spread at 45 and 60 DAT. An advanced 50% flower bud appearance and 50% flowering with maxium flower diameter, flower stalk length, shelf life, weight of ten flowers were also recorded with the application of GA_3 @ 200 ppm.

Keywords: Plant growth regulator, salicylic acid, GA_3, NAA, Arka Archana

Introduction
In the family Asteraceae, the China aster (*Callistephus chinensis*) is a prominent commercial loose flower as well as cut flower crop. China aster is a native of China and Europe. The genus *Callistephus* is derived from two greek words, *Kalistos* meaning 'most beautiful' and *Stephus* meaning 'a crown' referring to flower head. It was first named by Linnaeus as *Aster chinensis* and Nees changed the name to *Callistephus chinensis.* China aster is annual flowering plant. It is a very well-liked flower crop and primarily grown for production of loose flowers and cut flower also. It is widely used in backyard as herbaceous borders and as a bedding plant. It has been raised in pots and the dwarf cultivars are good for edges. Due to its simple practices, wide range of colors, and numerous uses, it is rapidly acquiring popularity in India. It can be combined with numerous cut flowers for making bouquets. It is adaptable to different agro climatic zones.

The primary objectives of commercial flower production are to increase flower production while maintaining high standards for flowers and plant perfection which can be obtained within a short period of time and at least cost by using various plant growth regulators like gibberellic acid (GA_3), salicylic acid and naphthalene acetic acid (NAA). Plant growth regulators play a vital role in altering the morphology and physiology of the plants by acting as chemical messengers for intercellular communication. Growth regulators have different effects depending on the plant genus, species, variety, and concentration utilized. Keeping the mentioned data in mind, it is possible to optimize the effects of plant growth regulators on the growth and flowering of china asters in South Gujarat conditions.

Materials and Methods
The present investigation entitled "Influence of plant growth regulators on growth, flowering and yield of china aster var. Arka Archana" was carried out at Floriculture Research Farm, ASPEE College of Horticulture & Forestry, Navsari Agricultural University, Navsari during the *Rabi* season of 2020-21. The experiment was laid out in a Randomized Block Design (RBD) with three replications and ten treatments of GA_3 (100 ppm, 150 ppm, 200 ppm, respectively), Salicylic acid (50 ppm, 100 ppm, 150 ppm, respectively) and NAA (100 ppm, 150 ppm and 200 ppm, respectively) along with control (no spray). The treatments were applied as a foliar spray at 45 and 60 days after transplanting. Solutions of GA_3, Salicylic acid

and NAA at different concentrations were prepared by dissolving calculated quantity of chemicals in small quantity of absolute alcohol. Uniform, healthy and well developed about 30-45 days old seedlings of China aster with 3-4 true leaves stage were transplanted at a spacing of 30 cm X 30 cm and all the standard package of practices were followed as per the requirement of China aster. Different growth and flowering characteristics were observed and noted. The gathered data for all the characters were subjected to the statistical analysis by adopting 'Analysis of Variance' technique as described by Panse and Sukhatme (1985) [10] for Randomized Block Design.

Results and Discussion

Vegetative attributes

The outcomes regarding the vegetative growth were affected by foliar application of plant growth regulators on China aster are furnished in Table 1.

An analysis of the data showed in table 1 that using various plant growth regulators at 45 and 60 DAT significantly raised plant height. Numerically, higher plant height (32.25 cm and 36.89 cm, respectively) was recorded with the foliar application of GA_3 200 (T_3) ppm which was statistically at par with the T_4 - Salicylic acid 50 ppm (29.81 cm and 33.29 cm, respectively). Whereas, control (T_{10}) was recorded least in plant height (17.17 cm and 18.18 cm, respectively). According to data gathered at different stages of plant development, an increase in GA_3 concentration also results in a rise in plant height. This may be explained by GA_3's ability to stimulate the production of mRNA for hydrolytic enzymes and to increase cell growth, both of which ultimately result in longer internodes. GA_3 had higher mitotic index in the sub-apical meristem and there might have enhanced cell division in this region. Rapid internodes extension caused by cell division and cell elongation is what caused the increased plant height. Similar result was found by Benny *et al*. (2017) [2] in carnation and Vijaykumar *et al*. (2017a) [14] in china aster cv. Local, Ragini Maurya *et al*. (2018) [12] in china aster, Sharma and Joshi (2015) [13] in china aster.

Maximum number of primary branches (12.27 and 13.40, respectively) were observed with the application of GA_3 200 ppm (T_3) which was statistically at par with the T4 - Salicylic acid 50 ppm (11.80 and 12.73, respectively), T2 - GA3 150 ppm (11.67 and 12.60, respectively) and T1 - GA3 100 ppm (11.27 and 11.73, respectively). Whilst, least number of primary branches (9.40 and 9.87, respectively) were recorded with control (T_{10}). Hyper-extension of internodal length results in an increase in plant height, and an increase in the number of nodes on the main axis leads to an increase in the number of buds from which major branches emerge. This is in concurrence with the findings of Kumar *et al*. (2010) [3] in African marigold, Neha Chopde *et al.* (2015) [8] in gladiolus and Palekar *et al.* (2018) [9] in China aster var. Phule Ganesh White.

Moreover, maximum stem diameter (6.29 mm and 7.36 mm, respectively) was noted with the application of GA_3 200 ppm (T_3) which was statistically at par with the T_4 - Salicylic acid 50 ppm (5.86 mm 6.90 mm, respectively). While, minimum stem diameter (4.04 mm and 4.92 mm, respectively) was observed with T_{10} - Control. The stimulation of the cambium and its immediate cell progeny results in a rise in stem diameter with increasing GA_3 concentration. These results corroborate with the findings of Kumar *et al.* (2010) [3] in African marigold cv. Pusa Narangi Gainda and Kumar *et al.* (2012) [4] in rose cv. First Red.

Significantly highest plant spread in East-West direction (25.80 cm and 32.41 cm) and North-South direction (26.98 cm and 32.42 cm) was noted with GA_3 (T_3) at 45 and 60 DAT, respectively. Whereas, least plant spread in E-W direction (15.93 cm and 18.85 cm, respectively) and in N-S direction (15.27 cm and 18.05 cm, respectively) was recorded with treatment T10 - Control. Rapid internode elongation, which is again caused by increased cell division and enlargement, may be the cause of the enlarged nodes, this mostly confined to sub-apical meristem, the elongation of internodes will gradually increase the spread of the plants. Results are in accordance with the finding of Vijaykumar *et al*. (2017a) [14] in China aster and Kumar *et al*. (2010) [4] in African marigold cv. Pusa Narangi Gainda.

Maximum leaf area (13.08 cm^2 and 14.62 cm^2, respectively) at 45 and 60 DAT were observed in treatment T_3 - GA_3 200 ppm and minimum were noted in treatment T10 - Control (7.98 cm^2 and 9.59 cm^2, respectively).

Table 1: Effect of plant growth regulators on vegetative characters of China aster var. Arka Archana

Treatments	Plant height (cm)		No. of primary branches		Stem diameter (cm)		Plant spread (cm)				Leaf area (cm^2)	
							E-W		N-S			
	45 DAP	60 DAP	45 DAP	60 DAP	45 DAP	60 DAP	45 DAP	600 DAP	45 DAP	60 DAP	45 DAP	60 DAP
T_1: GA_3 100 ppm	26.20	28.59	11.27	11.73	5.49	6.38	21.35	26.17	21.68	25.91	10.73	12.55
T_2: GA_3 150 ppm	28.66	30.23	11.67	12.60	5.53	6.41	23.27	27.67	23.74	27.92	11.09	12.60
T_3: GA_3 200 ppm	32.25	36.89	12.27	13.40	6.29	7.36	25.80	32.41	26.98	32.42	13.08	14.62
T_4: Salicylic acid 50 ppm	29.81	33.29	11.80	12.73	5.86	6.90	24.36	28.33	24.44	29.31	11.63	12.76
T_5: Salicylic acid 100 ppm	24.02	28.19	10.47	11.33	5.39	6.22	19.22	23.90	19.49	24.19	10.03	11.12
T_6: Salicylic acid 150 ppm	23.31	26.31	10.33	11.13	5.37	6.19	19.17	23.77	18.55	22.99	9.96	11.08
T_7: NAA 100 ppm	19.27	21.35	10.00	10.27	4.39	5.81	16.17	19.55	16.23	18.47	8.19	9.86
T_8: NAA 150 ppm	22.07	24.32	10.07	10.93	5.07	5.94	17.12	19.73	16.62	19.81	9.26	10.58
T_9: NAA 200 ppm	22.53	24.51	10.13	11.07	5.26	6.12	17.66	20.47	17.57	20.59	9.65	10.70
T_{10}: Control	17.17	18.18	9.40	9.87	4.04	4.92	15.93	18.85	15.27	18.05	7.98	9.59
S.Em.±	1.19	1.38	0.60	0.63	0.25	0.31	1.24	1.62	1.12	1.53	1.12	1.24
C.D. @ 5%	3.53	4.09	1.77	1.87	0.73	0.93	3.68	4.82	3.33	4.55	NS	NS
C.V. %	8.40	8.76	9.62	9.49	8.07	8.69	10.73	11.66	9.68	11.08	19.04	18.68

Flowering attribute

The results regarding various flowering and quality attributes of china aster var. Arka Archana as influenced by plant growth regulators were presented in Table 2.

Early 50% flower buds appearance (32.33 days) and minimum days to 50% flower opening were recorded in T_3 *i.e.*, GA_3 200 ppm. Whereas maximum days taken for flower buds appearance (41.00 days) and 50% flower opening (62.00 days) were recorded with T_{10}- Control. Early flowering brought on by GA_3 treatment may be caused by a rise in endogenous GA_3 levels that increased photosynthesis area and respiration, improved CO_2 fixation, and increased N ratio in the plant, all of which are linked to early flowering. As a result, GA_3 is very efficient at shortening the plant's juvenile stage so that it can flower sooner. The apical meristem of shoot might have transformed into a flower premordia instead of producing leaves at the end of the juvenile period. The present findings thus agreed with Kumar *et al.* (2010) [4] in African marigold cv. Pusa Narangi Gainda, Sharma and Joshi (2015) [13] in china aster cv. Kamini, Patel *et al.* (2018) [11] in *limonium* var. Misty White and Palekar *et al.* (2018) [9] in china aster var. Phule Ganesh White.

Maximum diameter of flower (5.51 cm) was recorded by the application of GA_3 200 ppm (T_3) which was statistically at par with T_4 - Salicylic acid 50 ppm (5.28 cm) whereas, T_{10} - control was recorded least in flower diameter (4.20 cm). The lengthening of petals and pedicels may have contributed to the increase in floral size and diameter by attracting more photosynthates to the flower as a result of an enhanced sink. The results gained in the present investigation are in close agreement with the findings of Sharma and Joshi (2015) [13] in china aster, Munikrishnappa and Chandrashekar (2013) [7], Mamilla Sindhuja *et al.* (2018) [6], Palekar *et al.* (2018) [9], and Vijaykumar *et al.* (2017a) [14] in china aster.

Perusal of the data numerically showed maximum flower stalk length (11.77 cm) was recorded in T_3 - GA_3 200 ppm which was statistically at par with T_4 - Salicylic acid 50 ppm (10.49 cm) while the least flower stalk length was in T_{10} - Control (4.91 cm). The longer flower stalk may be a result of the branch's lengthening, the translocation of photosynthates to the flower as a result of intensification of sink, as well as greater cell division and elongation. This resulted in the maximal stalk length and straighter, thicker, and highly carbohydrate-accumulating stems. Similar results were also obtained by Kumar *et al.* (2012) [4] in rose cv. First Red, Vijaykumar *et al.* (2017b) [15] in China aster, Kumar *et al.* (2018) [5] in China aster cv. Ostrich Feather, Neha Chopde *et al.* (2015) [8] in gladiolus and Amin *et al.* (2017) in tuberose.

Longevity of flowers was not affected by the foliar application of different plant growth regulators on China aster.

Maximum shelf life (3.67 days) was recorded by the application of GA_3 200 ppm (T_3) which was statistically at par with T_4 - Salicylic acid 50 ppm (3.33 days), T_2 - GA_3 150 ppm (3.00 days), T_1 - GA_3 100 ppm (3.00 days) and T_5 – Salicylic acid 100 ppm (3.00 days). While, minimum shelf life (2.00 days) was recorded with T_{10} (Control). Maximum shelf life extension, which may be caused by a defined altered impact on plant vegetative and reproductive development. The results of present study are in close conformity with findings of Vijaykumar *et al.* (2017b) [15] in China aster cv. Local

Maximum weight of ten flowers (25.19 g) was recorded through the application of GA_3 200 ppm (T_3) which was statistically at par with T_2 - GA_3 150 ppm (23.64 g) and T_4 - Salicylic acid 50 ppm (22.72 g). Whereas, minimum weight of ten flowers (17.96 g) was noted in T_{10} - Control. The fact that GA_3 promoted plant effectiveness in terms of photosynthetic activity, nutrient uptake and translocation, as well as improved partitioning of assimilates into reproductive parts, may be the cause of the rise in flower weight in treated plants. These results are in agreement with those reported by Ragini Maurya *et al.* (2018) [12] in China aster.

Table 2: Effect of plant growth regulators on flowering characters of China aster var. Arka Archana

Treatments	Days to 50% flower buds appearance	Days to 50% flowering	Flower diameter (cm)	Flower stalk length (cm)	Longevity (days)	Shelf life (days)	Weight of ten flowers (g)
T_1: GA_3 100 ppm	36.00	55.33	4.80	9.72	16.07	3.00	21.22
T_2: GA_3 150 ppm	35.33	53.67	5.10	9.79	16.20	3.00	23.64
T_3: GA_3 200 ppm	32.33	51.33	5.51	11.77	16.93	3.67	25.19
T_4: Salicylic acid 50 ppm	34.67	53.33	5.28	10.49	16.87	3.33	22.72
T_5: Salicylic acid 100 ppm	38.00	56.67	4.62	6.90	15.73	3.00	20.95
T_6: Salicylic acid 150 ppm	38.67	57.33	4.59	6.13	15.40	2.67	20.87
T_7: NAA 100 ppm	39.33	60.33	4.48	5.06	13.67	2.33	19.33
T_8: NAA 150 ppm	39.33	59.67	4.55	5.15	14.33	2.33	20.00
T_9: NAA 200 ppm	38.67	59.00	4.57	5.43	14.73	2.67	20.59
T_{10}: Control	41.00	62.00	4.20	4.91	13.60	2.00	17.96
S.Em.±	1.68	1.40	0.25	0.64	0.95	0.27	1.27
C.D. @ 5%	4.99	4.15	0.75	1.89	NS	0.79	3.79
C.V. %	7.80	4.25	9.21	14.64	10.66	16.41	10.39

Conclusion

Inferences about the foliar application can be drawn from the findings of the current experiment that foliar application of 200 ppm GA3 at 30 and 45 days after transplanting gives better vegetative growth and flower quality in china aster cv. Arka Archana.

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